The STARBUCKS Problem

The first Starbucks opened in 1971 at Pike Place Market in Seattle. The chart below shows the growth of the company from the year 1988.

Year	1988	1990	1992	1994	1996	1998	2000	2002
Number	33	84	165	425	1015	1886	3501	5886

1. Create a scatterplot of the data, with the year representing number of years from 1988; i.e. enter 1988 as 0, 1990 as 2, etc.

2. What type of function would seem to best model the growth of Starbucks? _____

3. Using the model $n(t) = a \cdot b^t$, analytically find a function that fits the data. (You need to find values for "a" and "b".) On your calculator, graph n(t) to see how it fits the scatterplot.

$n(t) =$ _____

4. Use **ExpReg** (Exponential Regression) to find the exponential function n(t) that best fits the data. On your calculator, graph n(t).

$n(t) =$ _____

5. Using the exponential regression function, find the projected number of Starbucks in the year 2004? (Note: You may want to turn off the scatterplot and your function.)

$n($ _____ $) =$ _____

6. Using the exponential regression function, find when the number of Starbucks will reach 11,000. Should we solve this problem algebraically or graphically?

$t =$ _____

7. We can also write the exponential function in the form $n(t) = a \cdot e^{k \cdot t}$, but we need to find the value of k. By comparing the forms of the equations $n(t) = a \cdot b^t$ and $n(t) = a \cdot e^{k \cdot t}$, it appears the $b = e^k$. Substitute the value of b from the regression function into this equation and solve for k. Write k to 4 decimal places, and write the equation n(t) below.

$k \approx$ _____ and $n(t) =$ _____

8. Earlier we determined that, according to the exponential regression model, the projected number of Starbucks in the year 2004 would be _____. We now know that in 2003 there were 7225 Starbucks, and in 2004 there were 8337 stores. Add these values to the scatterplot. How does the exponential growth model fit the function with these new values?

9. A better fitting model now would be a **logistic function**. Using the regression capabilities of the calculator, find a logistic function that fits the data.

$n(t) =$ _____

10. Does the logistic growth model show an "upper limit" to the number of Starbucks stores? Change the window to see if the graph appears to have a horizontal aymptote as x gets bigger. If it does, what is it?

$y =$ _____

Where does this number appear in the logistic function? _____

11. Use the logistic function to estimate when the number of Starbucks reaches 11000. Solve the equation graphically.

$t =$ _____